

Dear Nonroad Manufacturer:

Subject: Deterioration Factors for Nonroad Diesel Engines

This letter supercedes and corrects our earlier letter of February 28, 2000. We are providing guidance on developing deterioration factors (DFs) by engineering judgement, engineering analysis, and dynamometer service accumulation.

If you manufacture engines with ratings less than 37 kilowatts, you should have started using DFs in model year 1999. If you manufacture engines with ratings greater than or equal to 37 kilowatts, you will need to develop DFs for your certification to Tier 2 standards which begin taking effect for some power categories as early as the 2001 model year. DFs are required for all pollutants including smoke. This document provides guidance on generating and applying DFs.

Engines must comply with emissions standards throughout their useful lives. Certification engines are tested with up to 125 hours of service accumulation. By definition, the useful life for engines ranges from 3000 to 8000 hours depending upon the power category. Deterioration factors are applied to account for any increase in emissions over the useful life of an engine. DFs are usually developed using an engine which is run strictly for aging purposes, and are applied to the emission results from the certification engine. The certification engine must comply with emissions standards after the DFs are applied. DFs are also applied to test results during a Selective Enforcement Audit (SEA).

Nitrogen oxides (NO_x), nonmethane hydrocarbons (NMHC), carbon monoxide (CO) and particulate matter (PM) DFs for engines with aftertreatment devices are multiplicative. Multiplicative DFs are the ratios of the emissions measured (or extrapolated) at the end of the engine's useful life to the emissions measured at the 125 hour point (or other point of stabilized emissions). A multiplicative DF cannot be less than 1.000. Engines without aftertreatment have additive NO_x, NMHC, CO and PM DFs. Smoke DFs are additive for all engines. Additive DFs are determined by subtracting emissions measured at the 125 hour point (or other point of stabilized emissions) from the emissions measured (or extrapolated) at the end of the engine's useful life. An additive DF cannot be less than 0.000. You may, with EPA approval, use DF data for multiple model years ("carryover" DFs). In considering requests to use "carryover" DFs, EPA will evaluate whether there have been any emissions related changes to the engine. For established technologies, with EPA approval, you can also use DFs which you developed for one family on other families if they use similar technologies.

For all engines, to calculate the final NMHC+NO_x emission result, first apply (i.e., through addition or multiplication according to the type of DF) your NO_x DF to your NO_x result and your NMHC DF to your NMHC result. Then add the deteriorated NO_x value and the deteriorated NMHC value to determine the deteriorated NMHC+NO_x result.

Using engineering judgement to develop DFs for engines under 37 kW for model years 1999 and 2000

Given the short time from the signing of the final rule to its implementation for under 37 kW engines, paragraph 89.118(e)(3)(iv) provides an interim procedure for model years 1999 and 2000. Manufacturers may determine deterioration factors based on good engineering judgement and reasonably available information.

For engines under 37 kW for the 1999 and 2000 model years, EPA is accepting DFs determined using “good engineering judgement” and reasonably available emissions data on aged engines. If you are doing dynamometer testing to generate DF data, no minimum amount of service accumulation is specified for these model years. You should, however, be prepared to provide the basis you used to develop your DFs.

If you do not have sufficient data of your own on emissions or other engine parameters, EPA may consider DFs prepared for similar engines by other manufacturers to be “reasonably available information” and may approve DFs for you based on this.

For 2001 model year certification, EPA expects under 37 kW engine manufacturers to have completed their own DF analysis. This DF analysis should be conducted as discussed in the following section on deterioration factors for engines with established technology or by durability testing on an engine dynamometer. For some manufacturers, carryover of 2000 model year DFs may not be accepted because of insufficient emissions deterioration data. We encourage you to discuss your DF plans for model year 2001 with us as soon as possible.

Deterioration Factors for Engines with Established Technology

Engines are considered established technology if they do not use EGR or aftertreatment and have certification levels above the Tier 3 NMHC+NO_x standard. DFs for these engines may be developed using engineering analysis per 89.118(e)(3)(iii). As the preamble to the 1998 final rule (63 Fed. Reg. 56968, 56974) explains, this provision allows manufacturers to develop DFs without doing service accumulation on an engine dynamometer. For instance, in the case where no durability data exists for a certain engine but both smaller and larger engines using similar technology have been shown not to deteriorate for NO_x in use, it may be possible to build a case showing no NO_x deterioration for that engine.

We will not consider as “good engineering analysis” a NO_x DF of zero based on the assumption that

NOx emissions decrease with increasing engine wear. One form of acceptable good engineering analysis relates changes in measurable parameters to changes in exhaust emissions. For example, a PM DF may be determined by relating increased oil and fuel consumption to increased PM emissions. In this example, you should have data indicating the measured increase in fuel or oil consumption and the expected PM increase per change in fuel and/or oil consumption.

A manufacturer may use engineering analysis to develop their DFs from data generated by another manufacturer on an engine using similar technology. For example, a manufacturer of a turbocharged, mechanical direct injection, nonroad diesel engine may use as a basis for its DF analysis data generated by another manufacturer on a similar engine. In this example, the nonroad manufacturer should list the similarities between the two engines which will cause them to have similar DFs. Also, the nonroad manufacture should note any differences between the two engines and explain the effect of these differences on the deterioration factors generated by the other engine manufacturer. In the case where a range of DF values exists for an engine technology, a manufacturer may not use an average of these values for the DF of its engine. The nonroad manufacturer should be prepared to justify its DF versus the range of DF values from other manufacturers.

Dynamometer testing of durability engines

Section 89.118(c) requires manufacturers to perform service accumulation in a manner using good engineering judgment to ensure that emissions are representative of those from in-use engines. Service accumulation may be performed using in-use engines or using a dynamometer to age the engines. EPA did not specify a durability test cycle for “aging” nonroad engines on a dynamometer. We consider any test cycle that is representative of actual in-use operation to be appropriate. This may include durability test cycles that incorporate modes from the certification test cycles. This could also include durability cycles that are more severe than the test cycle in the regulations that age the engine more rapidly than by repeated running of the emissions test cycle.

It may not be necessary to age an engine to its full useful life in order to determine useful life emissions. These emissions may be projected. To determine the emissions of engines at the end of their useful lives, manufacturers may extrapolate from testing performed during the service accumulation process. You should measure emissions at enough points during the durability testing to determine the change in emissions with time. You should measure emissions at more than just the beginning and end of your dynamometer testing. Your emission data points should be approximately equally spaced throughout your durability testing. Once you have accumulated enough emissions data to determine a trend, you may extrapolate to determine the useful life emissions. As an alternative to accumulating engine hours on a dynamometer, in-use engines may be tested at various hours throughout their useful life.

Allowable maintenance

Section 89.109 specifies allowable intervals for emissions related maintenance. Apply these maintenance intervals while accumulating hours on the durability engine. For critical emission-related components, you must document that there is a reasonable likelihood that the maintenance will occur in-

use. The regulations list options for demonstrating that the maintenance is occurring in-use. If you can't document that there is a reasonable likelihood that the maintenance will occur in-use, you can't perform the maintenance.

If you have any questions on the information in this letter, please contact Greg Orehowsky of my staff on 202-564-9292 or at orehowsky.gregory@epa.gov.

Sincerely,

Gregory A. Green, Director
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